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Techno-Economic and Environmental Assessment of By-product Coke-Making Using non-recyclable Waste Plastics: A European Perspective

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Amid growing economic and ecological challenges within the ironmaking industry, there is a clear need to transition towards cleaner production methods. One approach is the partial replacement of costly coking coal—a critical raw material in coke production—with non-recyclable waste plastics recovered from solid waste sources—materials that would otherwise be landfilled or incinerated. In this work, a techno-economic-environmental assessment of a standard European by-products coke-making plant is presented, based on prices from 2019, 2022, and 2023. Two scenarios were evaluated: the Benchmark Scenario, which involves conventional coke production using exclusively coking coal, and the AlterCoal Scenario, where 2 wt% of the coal is replaced with pellets derived from non-recyclable waste, referred to as solid recovered fuel (SRF). The study compares direct and indirect emissions, and gross profit between both scenarios, and examines the influence of coke plant design and SRF pellets density on gross profit and direct emissions. The results show that direct and indirect emissions are reduced by 11.2% and 5.7%, respectively, in the AlterCoal Scenario compared to the Benchmark Scenario. Over the three years analysed, the gross profit of the AlterCoal Scenario was higher than that of the Benchmark Scenario, primarily due to the decreased reliance on coking coal, the use of relatively cheap SRF pellets, and an increased production of coke oven gas. Moreover, increasing pellet density boosted the gross profit of the AlterCoal Scenario, albeit with a slight rise in carbon emissions. A linear correlation was identified between gross profit and oven pushes, demonstrating that fewer coke oven discharges per day lead to higher profitability. Finally, plant designs with fewer discharges per day generated higher gross profit per ton of CO₂ directly emitted.

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